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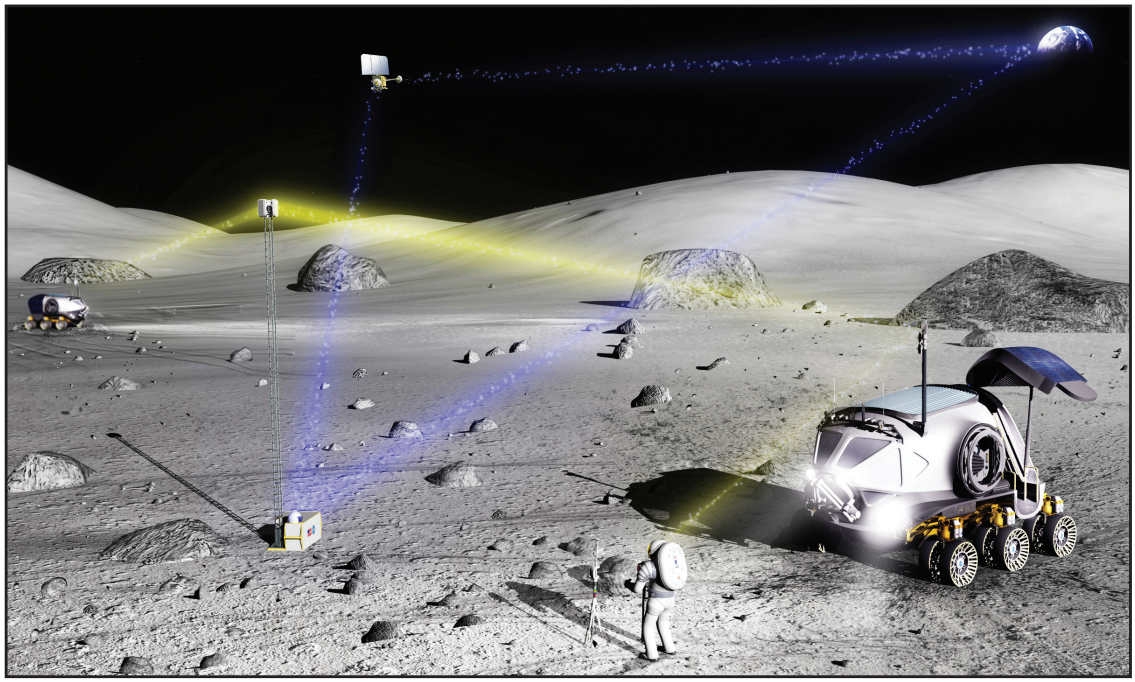
Portable Communication Terminal Concept



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A Portable Communication Terminal Concept (PCT) serves as a "cell tower" for surface or in-space explorers. A PCT conserves a rover's energy and increases the range between recharges by enabling it to use a lower power transmitter to push information to Earth. Rovers also use less energy because they can offload the high-rate communications equipment hosted by the PCT (carrying less mass) for long periods of mission time.

Background

Accurate tracking, timing, communications and networking (TTCN) services are essential for every mission in space. NASA is continuously seeking new ways to enable human and robotic missions to near Earth objects (NEOs) and planet surfaces to conduct a variety of missions with high levels of situational awareness and high-data-rate communications with Earth.

Rover missions to Mars are teaching NASA engineers that sacrificing power for communications directly with Earth greatly reduces its exploration range. As a result, the latest Mars rover designs have very limited direct-to-Earth communication, and depend heavily on relays to receive commands, navigate and send science data to Earth. Relays are essential to the success of these missions.

Radio communications spectrum is a valuable commodity, but with all the missions NASA has in space, Earth-based ground stations must be built-up, managed and maintained to support all the exploring vehicles and spacecraft. NASA continuously seeks innovative uses of spectrum and any capabilities that reduce the burden on the ground stations to receive and transmit data. This means if many exploring spacecraft can share a single "backhaul" link with Earth, it will reduce the complexity of the missions back on the "Earth side" of the links.

On planetary surfaces, every kilogram of mass that is carried by a rover reduces the amount of area the it can explore. In addition, human and robotic rovers seek to explore areas where TTCN services are not available. Rovers will benefit from carrying and deploying a portable TTCN terminal that can be "dropped" on the surface for long periods of time to offload mass, allowing more energy for them to explore. Such surface-based assets can provide TTCN "relay" capabilities for the exploring rovers, so they can maximize their energy usage, and maintain situational awareness and communication with other rovers and Earth.

Vehicles such as the Space Exploration Vehicle (SEV) seek to explore new and exciting regions of space where there is little or no existing TTCN capability today. These missions currently require the SEVs to carry TTCN capabilities with them to illuminate the unexplored regions of space, but carrying these capabilities as part of the vehicle could force them to serve solely as TTCN relay

vehicles for long periods of time during the mission. SEVs will benefit from having the capability to release and deploy small terminals into space while en route to their destination to perform these functions, without tying up crews and preventing exploration vehicles from conducting their primary mission -- to explore!

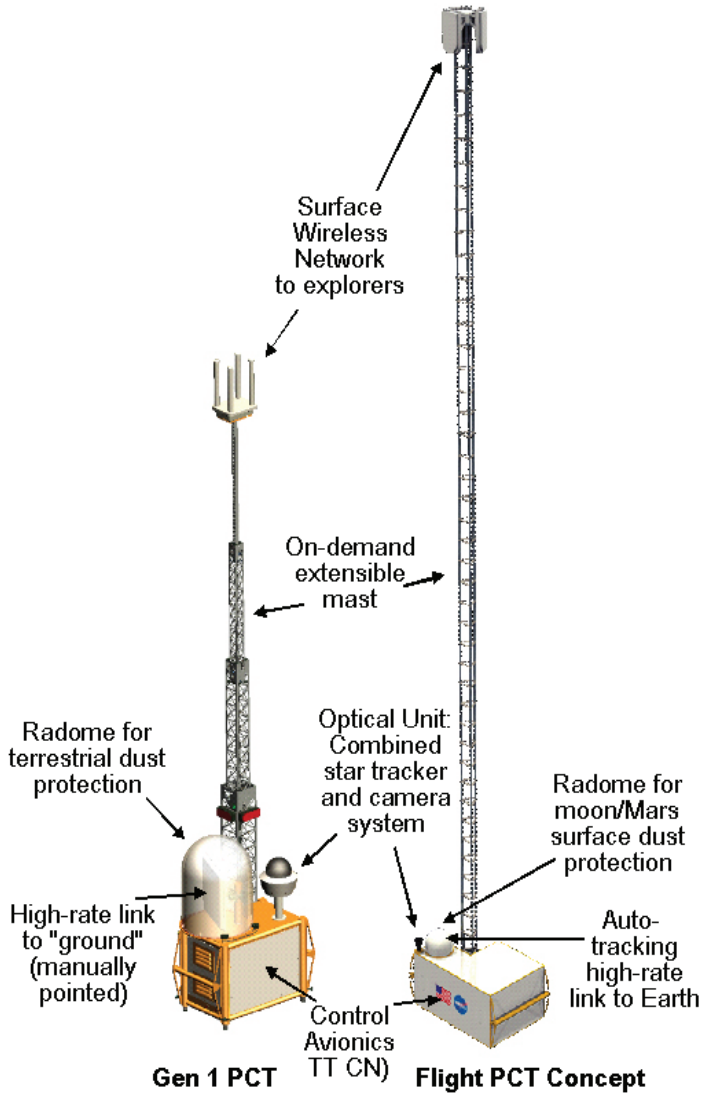
The Portable Communication Terminal

NASA is investigating the benefits of employing a small portable communications terminal (PCT) to support teams of exploring rovers and spacecraft. The PCT would provide TTCN relay capabilities for multiple exploring vehicles simultaneously -- on planetary surfaces and in space. Because the PCT would be deployed in generally "fixed" or "established" locations, it would reduce the burden for the team of explorers to a single element, and serve as a primary tracking, timing and navigation asset for the other elements working in proximity. Explorers near the PCT would count on it to determine their location and establish synchronized timing with Earth accurately, and share this information with them.

Exploring rovers and vehicles are built to explore. The more "new things" an exploring vehicle drives or flies to and examines, the more science they return. By offloading TTCN equipment nearby and using it as a relay in places where it is needed, such as Mars missions today, exploring vehicles will be able to conserve and put "more power into their wheels" by relaying TTCN through a PCT.

The PCT will enable human and robotic exploring vehicles and crews to focus on exploration into larger areas, and provide relay capabilities around and behind in-space objects that would normally be unreachable. This is especially important on planetary surfaces where rovers and crews seek to cooperate and explore into diverse terrain, such as up against steep cliffs or into canyons or craters, where no TTCN services are possible direct with Earth or even orbiting relays, but are possible with a well-positioned PCT.

From a communications perspective, the PCT also solves the Earth-side problem of spectrum management and "multiple access" for explorers. The PCT will combine, or "aggregate," all of the communications to and from explorers into a single data stream with Earth. This will require less ground stations on or near Earth to track and synchronize with the explorers, and will tie up less of the precious spectrum available to all missions.



Primary Functional Requirements:

- The PCT must be capable of determining its absolute position in space or on a planetary surface in a reasonable amount of time
- The PCT must be capable of using its absolute position information to then determine relative positions of other exploring vehicles in proximity, and share this information with them so they can navigate on their own
- The PCT must be able to receive timing information from Earth, and distribute this timing information with other exploring vehicles in proximity so they are synchronized within the temporal reference frame of the team
- The PCT must be able to store and forward commands and telemetry between explorers and the Earth when communications is available, through the use of advanced protocols, such as disruption tolerant networking (DTN)
- The PCT must have a high-power, high-data rate "direct with Earth" communications capability, and a medium rate, multiple access, low-power, local-proximity wireless communications capability
- The PCT must be capable of routing communications between explorers in proximity, aggregating communications from explorers to Earth into a single stream, and "splitting up" aggregate communications from Earth and transmitting the information to the right explorers
- The PCT must be capable of being transported and deployed in the right locations by large surface or in-space exploration rovers or vehicles (such as the SEV or Tri-ATHLETE)

PCT (Surface Concept) Specifications:

Mass: 150 kg

Aggregate data rate, to Earth (including via relays):
> 100 megabits/second

Aggregate data rate, from Earth (including via relays):
> 25 megabits/second

Deployable mast height/length: > 10m

Stowed volume for transport: < 0.5 m2

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